



Novel Crack Stopper Concept for Lightweight Foam Cored Sandwich Structures – Experimental Validation, Fe-Modelling and Potential for Use in Structures

Martakos, Georgios; Andreassen, Jens H.; Berggreen, Christian; Thybo Thomsen, Ole

Publication date:
2016

Document Version
Peer reviewed version

[Link back to DTU Orbit](#)

Citation (APA):

Martakos, G., Andreassen, J. H., Berggreen, C., & Thybo Thomsen, O. (2016). *Novel Crack Stopper Concept for Lightweight Foam Cored Sandwich Structures – Experimental Validation, Fe-Modelling and Potential for Use in Structures*. Abstract from 17th European Conference on Composite Materials , Munich, Germany.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

NOVEL CRACK STOPPER CONCEPT FOR LIGHTWEIGHT FOAM CORED SANDWICH STRUCTURES – EXPERIMENTAL VALIDATION, FE-MODELLING AND POTENTIAL FOR USE IN STRUCTURES

Georgios Martakos¹, Jens H. Andreasen², Christian Berggreen³ and Ole Thybo Thomsen⁴

¹ Siemens Wind Power, Denmark

² Department of Mechanical and Manufacturing Engineering, Aalborg University, Aalborg, Denmark

³ Department of Mechanical Engineering, Technical University of Denmark, Denmark

⁴ Faculty of Engineering and the Environment, University of Southampton, Southampton,
United Kingdom

Keywords: Sandwich structures, Damage tolerance, Face-sheet/core debond, Crack stopper

ABSTRACT

A novel crack arresting device has been implemented in foam cored composite sandwich beams panels and tested under both static and fatigue loading conditions. Fatigue crack propagation was induced in the face-core interface of the sandwich panels which met the crack arrester. The effect of the embedded crack arresters was evaluated in terms of the achieved enhancement of the damage tolerance of the tested sandwich beams and panels. Finite element (FE) modelling of the experimental setups was used for predicting propagation rates and direction of the crack growth. The FE model predicts the energy release rate and the mode mixity based on the derived crack surface displacements, utilizing algorithms for the prediction of accelerated fatigue crack growth as well as the strain field evolution in the vicinity of the crack tip on the surface of the sandwich specimens. Finally, a comparison between the experimental results and the numerical simulations has been made to validate the numerical predictions as well as the overall performance of the crack arresters. Based on a linear elastic fracture mechanics approach, the developed FE model was utilized to simulate crack propagation and arrest in foam cored sandwich beam and panel specimens subjected to fatigue loading conditions. The effect of the crack arresters on the fatigue life is analysed, and the predictive results are subsequently compared with the observations from fatigue tests. Overall it was demonstrated that the proposed crack arrester device was indeed capable of deflecting and arresting propagating face-sheet/core interface cracks, and further that the use of embedded crack stoppers is capable of extending the fatigue life very significantly. It was further demonstrated that the developed numerical analysis procedures provide predictions that are in excellent agreement with the experimental observations.

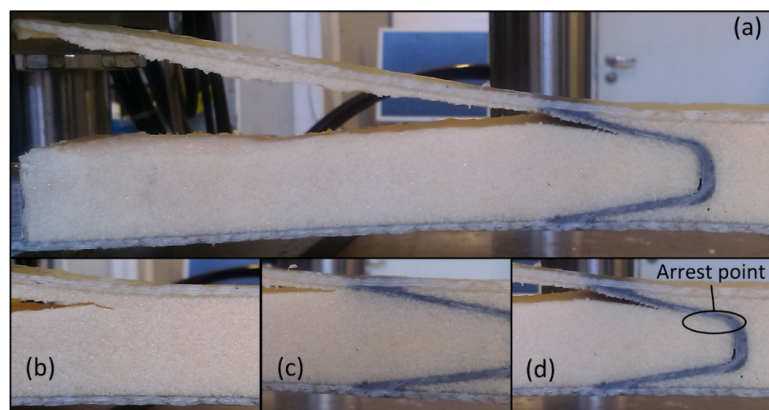


Figure 1: Crack stopper embedded in GFRP/foam core sandwich panel.

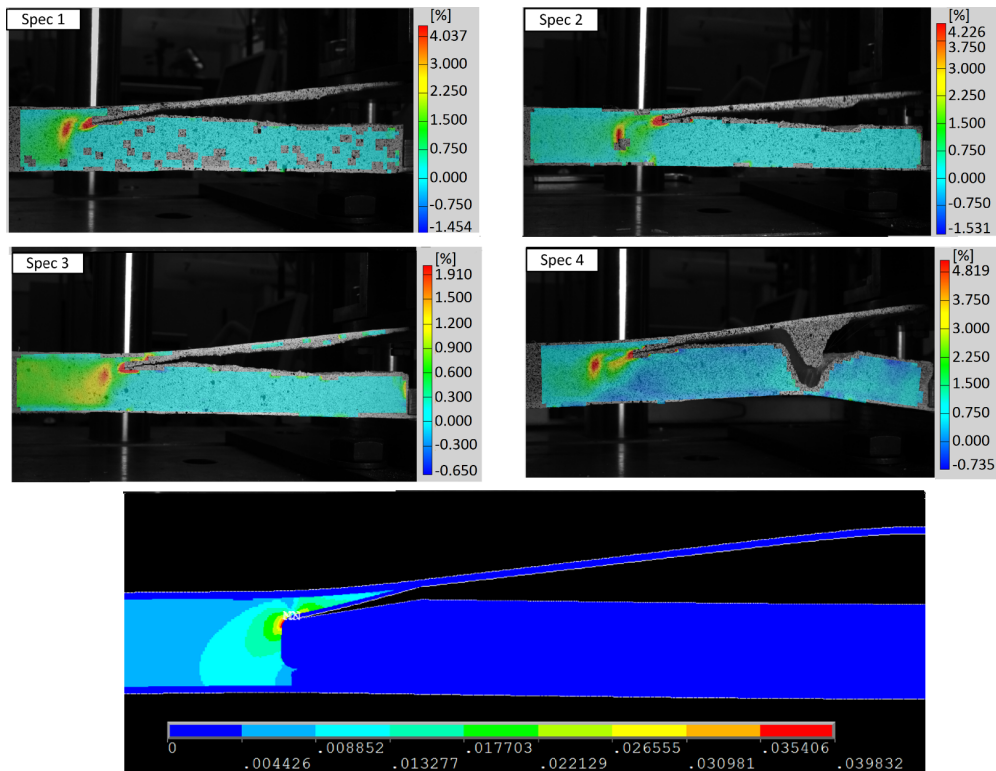


Figure 2: DIC measurements vs. FE analysis results at crack arrest.

ACKNOWLEDGEMENTS

The work was sponsored by the Danish Council for Independent Research | Technology & Production Sciences (FTP) under the research grant "Enhanced performance of sandwich structures by improved damage tolerance" (SANTOL) (Grant 10082020). The Divinycell H100 material used in this study was provided by DIAB Group, Sweden. The work has been conducted in collaboration with and co-sponsored by the Technical University of Denmark, Aalborg University, Denmark, the University of Southampton, UK, Siemens Wind Power A/S, Denmark, and LM Wind Power Blades A/S, Denmark.

REFERENCES

- [1] Martakos, G., Martakos, G., Andreasen, J.H., Berggreen, C., Thomsen, O.T., Interfacial crack arrest in sandwich panels with embedded crack stoppers subjected to fatigue loading. *Applied Composite Materials*. Accepted for publication. Available online early (doi: [10.1007/s10443-016-9514-3](https://doi.org/10.1007/s10443-016-9514-3)), 2016.
- [2] Martakos, G., Andreasen, J.H., Berggreen, C., Thomsen, O.T., 2016, Experimental Investigation of Interfacial Crack Arrest in Sandwich Beams Subjected to Fatigue Loading using a Novel Crack Arresting Device. *Journal of Sandwich Structures and Materials*. Accepted for publication, 2016.
- [3] Martakos, G., Andreasen, J.H., Berggreen, C., Thomsen, O.T., 2016, Experimental Investigation of Interfacial Crack Arrest in Sandwich Beams Subjected to Fatigue Loading using a Novel Crack Arresting Device. *Journal of Sandwich Structures and Materials*. Accepted for publication, 2016.